



US005804709A

# United States Patent [19]

[11] Patent Number: **5,804,709**

**Bourgoin et al.**

[45] Date of Patent: **Sep. 8, 1998**

[54] **CANTILEVER DEFLECTION SENSOR AND USE THEREOF**

[75] Inventors: **Jean-Philippe M. Bourgoin**, Montigny le Bx, France; **Matthew B. Johnson**, Norman, Okla.; **Bruno Michel**, Gattikon, Switzerland

[73] Assignee: **International Business Machines Corporation**, Armonk, N.Y.

[21] Appl. No.: **718,339**

[22] PCT Filed: **Feb. 7, 1995**

[86] PCT No.: **PCT/EP95/00431**

§ 371 Date: **Oct. 3, 1996**

§ 102(e) Date: **Oct. 3, 1996**

[87] PCT Pub. No.: **WO96/24819**

PCT Pub. Date: **Aug. 15, 1996**

[51] Int. Cl.<sup>6</sup> ..... **G01B 7/34**

[52] U.S. Cl. .... **73/105; 250/306**

[58] Field of Search ..... **73/105; 250/306, 250/307**

[56] **References Cited**

**U.S. PATENT DOCUMENTS**

4,724,318	2/1988	Binnig	250/306
4,851,671	7/1989	Pohl	250/306
5,065,103	11/1991	Slinkman et al.	324/458
5,171,992	12/1992	Clabes et al.	250/306
5,267,471	12/1993	Abraham et al.	73/105

5,354,985	10/1994	Quate	250/306 X
5,444,244	8/1995	Kirk et al.	250/306
5,445,011	8/1995	Ghislain et al.	73/105
5,461,907	10/1995	Tench et al.	73/105
5,465,046	11/1995	Campbell et al.	324/244
5,517,280	5/1996	Quate	355/71

**OTHER PUBLICATIONS**

*Patent Abstracts of Europe* (EP-290648) dated Nov. 17, 1988 "Atomic Force Sensor Head for Investigating the Topography of a Surface", Binnig et al.  
*Electronic Letters* 3 Dec. 1992, UK, vol. 28, No. 25, pp. 2302-2303 A.S. Hou et al. "Picosecond Electrical Sampling using a Scanning Force Microscope".  
*Physical Review B (Condensed Matter)* 15 May 1990, USA, vol. 41, No. 14 pp. 10229-10232, W. Krieger et al. "Generation of Microwave Radiation in the Tunneling Junction of a Scanning Tunneling Microscopic".

*Primary Examiner*—Thomas P. Noland  
*Attorney, Agent, or Firm*—Stephen S. Strunck

[57] **ABSTRACT**

A new method and an apparatus for measuring the deflection of or the force exerted upon a cantilever-type micromechanical element is presented which is based on detecting radiation emitted from the gap between the cantilever (220) and a second surface (230, 231). The radiation, while occurring spontaneously at high frequencies when appropriately biasing the cantilever and the second surface by a voltage, can be enlarged by using external energy sources. The new method and apparatus is also applied to surface investigation, particularly to dopant profiling.

**20 Claims, 8 Drawing Sheets**

